

What is California Cleaner-Burning Gasoline and Why is Flexibility Required in California?

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California Environmental Protection Agency



Air Resources Board

Overview

- ❖ History of California's vehicle fuels program
- ❖ California's Cleaner-Burning Gasoline program
- ❖ Recent activities
- ❖ Summary and conclusion
- ❖ Future activities

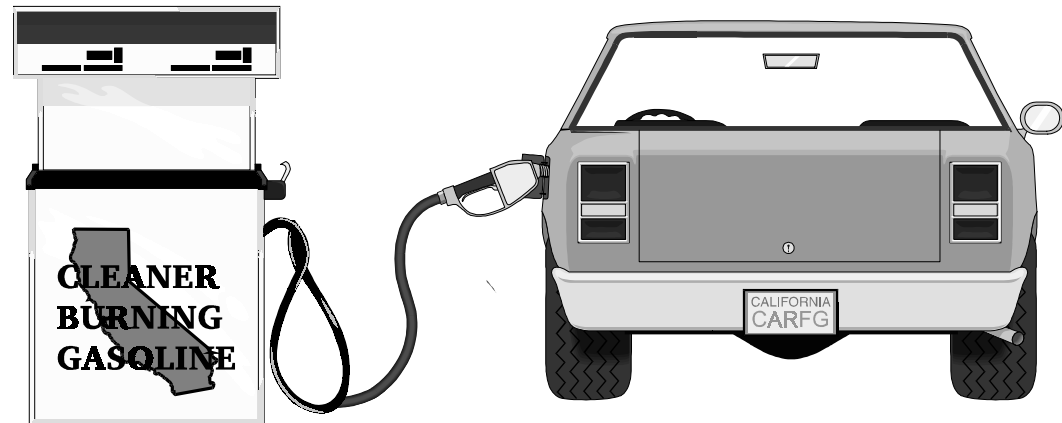
History of California's Vehicle Fuels Program

California Legislative Requirements for Mobile Sources

- ❖ Achieve maximum feasible reductions in PM, CO, and toxic air contaminants
- ❖ Achieve maximum emission reductions of VOC and NO_x by earliest practicable date
- ❖ Adopt most effective combination of control measures on all classes of motor vehicles and their fuels

Motor Vehicle Fuels Control Strategy

- ❖ Treat vehicles / fuels as a system
 - Vehicle emission standards
 - Fuel standards
 - Include lubricants
- ❖ Flexible



California's Gasoline Programs

Year Adopted	Gasoline Related Programs	Action
1971	Reid Vapor Pressure (RVP)	Limit RVP to 9 psi in smog season
	Bromine Number	Limit reactivity of evaporative emissions
1975	Sulfur	Protect catalysts
	Manganese/Phosphorus	
1976	Lead	Begin phase-out of lead
1982	Lead	Continue lead phase-out
1990	Phase 1 CaRFG	
	- Reid Vapor Pressure	Limit RVP to 7.8 psi in smog season
	- Lead Phase-Out	Lead completely phased-out
	- Deposit Control Additives	Prevent/remove deposits in fuel system
1991	Phase 2 CaRFG	Cleaner Burning Gasoline
	Wintertime Oxygenates	Required 2% oxygen in winter
1994	Phase 2 CaRFG Predictive Model	Provides flexibility and lower costs
1998	Deposit Control Additives	Prevent combustion chamber deposits

Source: ARB/SSD

California Cleaner-Burning Gasoline Program

California Cleaner-Burning Gasoline Program

- ❖ Emissions performance based fuel parameter limits, not on general emissions criteria
- ❖ Limits on the following parameters:

RVP*	Sulfur
T50	Benzene
T90	Aromatic Hydrocarbons
Olefins	Oxygen Content

* Only the summer RVP limit is fixed, at 7.0 psi

Emissions Response to Fuel Parameter Changes*

- ❖ RVP - Reduces evaporative VOC's
- ❖ Sulfur - Reduces VOC's, NO_x, sulfur oxides, toxics (improves catalyst effectiveness)
- ❖ Benzene - Reduces toxics

* Assumes holding other parameters constant and reduce subject parameter.

Emissions Response to Fuel Parameter Changes (continued)

- ❖ Aromatic Hydrocarbon - Reduces VOC's, NO_x, toxics
- ❖ Olefin - Reduces NO_x, toxics, slight increase in VOC's
- ❖ Oxygen - Reduces CO, VOC's, and toxics; increases NO_x
- ❖ T50 & T90 - Reduces VOC's, toxics, slight NO_x increase

* Assumes holding other parameters constant and reduce subject parameter.

Flexibility is Part of Cleaner-Burning Gasoline Program

	Typical Before CBG	Flat Limit Standard	Average Standard	Cap for All Gasoline
RVP, psi	7.8	7.0	-	7.0
Sulfur, ppmw	150	40	30	80
Aromatic HC, vol%	32	25	22	30
Benzene, vol%	2.0	1.0	0.8	1.2
Olefins, vol%	9.9	6.0	4.0	10.0
Oxygen, wt%	0	1.8-2.2	--	1.8*-2.7
T90, deg F	330	300	290**	330
T50, deg F	220	210	200	220

* Wintertime only

** Refinery cap = 310 deg F

Predictive Model

- ❖ Used for a majority of gasoline produced
- ❖ Provides alternative means of compliance through a statistical model
- ❖ Increases gasoline producer's flexibility
- ❖ Reduces compliance costs / improves production capability

Why Flexibility is Allowed

- ❖ Reduced capital expenditure by refiners by about 20%
- ❖ Allows refiners to adjust to unexpected events without interruptions
- ❖ Minimizes production costs and increases supplies
- ❖ No loss in emissions benefits
 - On average produces a modest decrease in emissions

Emission Reductions¹ from Cleaner-Burning Gasoline

	Percent	TPD
Volatile Organic Compounds (VOC)	17%	190
Oxides of Nitrogen (NO _x)	11%	110
Sulfur Dioxide (SO ₂)	80%	30
Carbon Monoxide (CO)	11%	1300
Toxic Compounds Risk	40%	

1. Based on on-road exhaust and evaporative emissions in 1996

Emissions Reductions Comparison

Pollutant	Federal RFG		California RFG
	Phase I (1995)	Phase II (2000)	(1996)
VOC	9%	15%	17%
NO _x	4%	4%	11%
CO	11%	11%	11%
SO ₂	0%	0%	80%
Cancer Risk	30%	40%	40%

Benefits of Cleaner-Burning Gasoline

- ❖ Emission reductions equivalent to removing 3.5 million vehicles from California roads
- ❖ Reduces smog forming emissions from motor vehicles by 15%
- ❖ Reduces potential cancer risk from vehicle emissions by 40%
- ❖ 1/4 of SIP reductions in 1996
- ❖ Reduces benzene emissions by half

Other Benefits

- ❖ Reduces combustion chamber deposits
- ❖ Allows vehicle manufacturers to improve engine technology to reduce emissions further

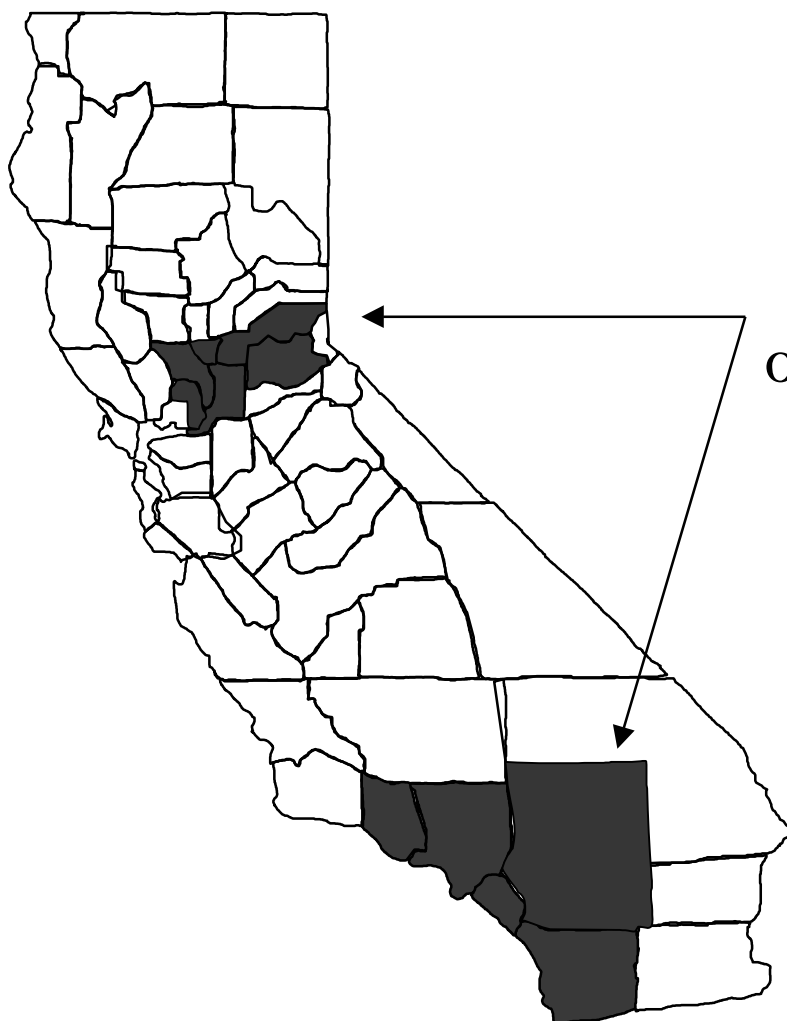
Air Quality Benefits

- ❖ Ambient benzene emissions cut in half
 - Northern California (Spring 1995 to Spring 1996)
 - Southern California (Spring 1994 to Spring 1996)
- ❖ Significant ozone reductions due to Cleaner-Burning Gasoline
 - South Coast Air Basin (10%)
 - Sacramento (12%)
- ❖ Reduced formation of fine particles

Oxygen Requirements in California

- ❖ California's rules are flexible, can be met without oxygen, except in winter in some areas
- ❖ California now allows all oxygenates approved by U.S. EPA
- ❖ All oxygenates are regulated equally, refiners choose the oxygenates, if any
- ❖ Federal minimum oxygen content prevents use of flexibility in most of state

Federal Minimum Oxygen Content Applies to Federal RFG Areas



Affects about 70%
of gasoline sold in California

Why Oxygenates Are Used

- ❖ Required by Congress
- ❖ Current refiners configured to take advantage of oxygenates, specifically MTBE
- ❖ Provide octane benefits
- ❖ Expand production volume
- ❖ Assist in producing complying gasoline
 - Depress T_{50}
 - Lowers sulfur, aromatics, benzene and olefins

Emissions Effects of 2% Oxygen in Gasoline

- ❖ 10% CO reduction
- ❖ 3% HC reduction
- ❖ 2% NO_x increase
- ❖ Dilutes other properties such as sulfur, olefins, aromatics, and T50
- ❖ However, with the exception of CO, all of these effects can be accomplished by forgoing oxygenates and modifying other properties

To Replace Oxygen and Maintain Ozone and Toxic Reduction Requires

- ❖ Minor increase in refining to reduce sulfur, olefins, etc. to offset dilution effect
- ❖ Further reduction in sulfur (~20 ppm) and T50 (~5 °C) to offset HC increase

Why Flexibility from Federal Oxygen Mandate is Needed and Appropriate

- ❖ Oxygen not essential to provide air quality benefits
- ❖ California's Cleaner Burning Gasoline provides necessary emissions benefits
- ❖ Reduced flexibility increases costs
- ❖ Oxygen mandate makes it difficult to reduce MTBE use; ethanol is effectively the only alternative

Recent Activities

Winter Oxygen Rescission

- ❖ Recently rescinded minimum oxygen requirement except for South Coast area (Los Angeles region)
 - Required a two-year delay in Fresno and Tahoe, to protect state CO standard (Ends February 2000)
- ❖ As a result refiners are free under California rules to produce oxygenate free gasoline in most of California

Ability to Use Ethanol

- ❖ Recently increased maximum oxygen cap statewide to 3.5 wt%
 - Allows use of 10% ethanol, provided fuel complies with predictive model requirements
- ❖ Determined ethanol blends should not be exempt from RVP requirements
 - ARB made finding that ozone-forming potential would increase if gasoline with 10% ethanol were exempt from RVP limits
 - All fuels must meet 7.0 psi RVP standard

Percent Change in Emissions for 10% Ethanol Blend with 1 psi RVP increase Compared to Complying Fuel*

	<u>RL Diff. Included</u>	<u>Likelihood (E>C)</u>
CO	-10%	0%
NO _x	14%	99%
THC	18%	>99%
NMOG	32%	>99%
OFP	21%	>99%
OFPCO	17%	>99%
TOX	13%	>99%
TOXPW	5%	92%

* Positive number indicates an increase in emissions for 10% ethanol blend with a one psi RVP increase

Findings

- ❖ Test program meets the criteria specified in HSC section 43830(g)
 - Independently verifiable automobile emission test data
 - Representative automobile fleet
- ❖ Test program results demonstrate that gasoline containing 10% ethanol with a 1 psi RVP increase results in increased ozone forming potential in comparison to complying gasoline
- ❖ Test program results are statistically significant with a high degree of certainty (>90%)

Findings (Continued)

- ❖ Test program results are consistent with the findings of previous test programs that evaluate the effect of fuel oxygen and RVP on motor vehicle emissions
- ❖ Test program results are consistent with modeling results using the US EPA complex model
- ❖ Independent peer review supports staff's evaluation
- ❖ Conclusion
 - 10% ethanol did not qualify for full RVP waiver

Future Activities / Conclusion

Future Activities

- ❖ Update predictive model
 - Add new vehicle technology group
 - Develop evaporative emissions model
 - Evaluate changes to specifications, including sulfur
 - Other work as appropriate

Conclusions

- ❖ Cleaner-Burning Gasoline provides significant and essential air quality benefits
- ❖ California is neutral as to type of oxygenate
- ❖ California is flexible on amounts of oxygenate
- ❖ Congressional mandate imposes oxygen requirements in California
- ❖ Flexibility to reduce use of oxygenates while maintaining benefits are limited without relief from federal mandate